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November 10, 2000

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Application For: Laser Communications Crosslink System
Inventor(s): M. A. Rolenz
Serial No.: 09/577,221 Contract No.: F04701-93-C-0094
Filing Date: 05/23/00 Contractor: The Aerospace Corporation

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Signed this 16th day of November 2000

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INVENTION DISCLOSURE

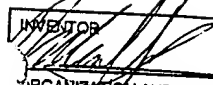
IN DISCLOSING THE INVENTION

1. Discuss the problem which the invention is designed to solve, referring to any similar devices.
2. State the advantages of the invention over devices presently known.
3. Describe the invention and its operation. If necessary, attach signed, witnessed and dated prints, etc.
4. List the features of the invention that are believed to be novel.
5. Have you publicly disclosed this invention? If yes, when? A valid patent cannot be obtained if the invention was publicly disclosed more than one year prior to the filing of a patent application.
6. Describe potential markets for this patent.
7. Send this disclosure to the Corporate Law Directorate.

~~as filed and witnessed~~

See Attached (3 pages)

PLEASE WRITE SIGNATURES AND DATES IN BLACK INK

INVENTOR 	DATE 1/15/99	INVENTOR	DATE	INVENTOR	DATE
ORGANIZATION AND CCC Comm. Sys. & Div. 5232		ORGANIZATION AND CCC		ORGANIZATION AND CCC	
WITNESSED, READ AND UNDERSTOOD BY: Wayne Fenner	DATE 1/15/99	AND BY: Albert M. Young	DATE 1/15/99		

Integrated Laser Crosslink and analog-to-digital convertor for transmission of signals

Inventor: M.A.Rolenz #17684

13 January, 1999

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IN DISCLOSING THE INVENTION

1. Discuss the problem which the invention is designed to solve, referring to any similar devices.

Laser crosslinks do not transmit analog signals directly very well. Analog signals must be converted to digital samples and the bits transmitted using some form of digital modulation (e.g., phase shift keying or on-off keying). Small satellites (e.g., nanosatellites) are not able to generate much power because of their small size. Use of laser crosslinks is desired to transfer received signals to another satellite for processing. Low power components, and reduction of components are required to meet the stringent power requirements. Furthermore, reduction of the numbers of component is desired to increase reliability and reduce fabrication complexity. The problem is to transmit these digital sample with as few components as possible.

2. State the advantages of the invention over devices presently known.

The traditional approach to transmitting digitized information over a crosslink is to multiplex the parallel output of the analog to digital converter into a ordered serial data stream. Add redundant bits into the bit stream for synchronization and error correction/detection. This invention eliminates the need for additional synchronization and error correction/detection since it is oversampling and self synchronizing.

This invention requires fewer parts and less power by integrating the Analog to digital conversion and transmission into one system. By using sigma-delta conversion, it reduces the roll-off requirements and manufacturing tolerances for anti-aliasing filters in the front of the analog to digital converter of the satellite transmitting the crosslink signal reducing, manufacturing tolerances and required performance.

It simplifies laser crosslink design over traditional PSK by direct modulation of the laser by the data stream.

3. Describe the invention and its operation. If necessary, attach signed, witnessed and dated prints, etc.

In this invention, the output sigma-delta modulator of a traditional analog-to-digital converter (± 1 output) is converted to on-off (0,1) signal and then input to the on-off laser modulator. This laser is used as a crosslink to another satellite. This satellite has a simple detector which determines when the received signal from the laser is on or off. This binary signal is converted to +1 or -1 and input to a the digital filter (as in the other half of the sigma delta analog to digital converter). By changing the clock speed, order of the sigma delta modulator on the transmitting satellite, and the size of the decimating digital filter on the receiving satellite, nearly any number of A/D bits of resolution (up to the bit capacity of the laser cross link) can be realized. The link may operate at high resolution and low capacity or low resolution and high capacity. If these are made variable parameters, then the invention allows the crosslink to be adapted for the type of data without requiring different hardware.

If the output of the laser detector is a continuous voltage rather than a 0 or 1, then this may be converted to an n-bit digital word between [-1,1] to implement soft decision type of algorithms for the interpolation function.

4. List the features of the invention that are believed to be novel.

In the sigma-delta analog-to-digital converter, the sigma-delta modulator and digital interpolating filter are an integrated package. In this invention, the two are placed at physically separated locations

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communication path between them provided by a laser crosslink. This system integrates a sigma-delta analog to digital converter with a laser crosslink to simplify the design of both. The high bandwidth available from the crosslink (NOTE: this is applicable to FIBER OPTICS AS WELL) permits the direct transmission of the oversampled data stream output by the sigma-delta modulator. Since that output is oversampled already, this eliminates the normally required synchronization and error correction detection on the digital link. Since the digital sample is reconstructed using a digital filter filtering a continuous stream of data, it is less susceptible to errors in the transmission of data than in traditional framed data where the probability of error for bits is the same but the effects of errors is more severe with the most significant bits.

5. Have you publicly disclosed this invention? If yes, when? A valid patent cannot be obtained if the invention was publicly disclosed for more than one year prior to the filing of a patent application.

No.

6. Describe potential markets for this patent.

Satellite communication systems employing crosslinks or fiber optics where digitized information such as voice, received radio signals is being transmitted to another location or satellite. One application of small satellites is a constellation of satellites containing signal receivers using nanosatellites. The digitized samples of the received signals to other satellites for processing over a laser crosslink.

Other uses include signals intelligence collection, digital nonregenerative transponders, fiber optics.

Collection of low bandwidth signals with high resolution at low power levels.

7. Send this disclosure to the Corporate Law Directorate.

Analog to Digital Converter
Section

Laser Crosslink/Fiber Optic
Section

Output of Sigma-Delta
Modulator is $\{-1,1\}$ of
varying durations

Analog
Signal
Input

Sigma
Delta
Modulator
(Of A/D)

Convert
 $\{-1,1\}$
to
 $\{0,1\}$

Pulse
Laser
Modulator

Power starved Satellite
(e.g, Nanosatellite)

Laser Crosslink
or fiber optics
transmission
medium

Pulse Width
Modulation

"Mothership"

n-bit
Digital
Sample

Digital
Filter
(of A/D)

Clock
Recovery

Convert
 $\{0,1\}$
to
 $\{-1,1\}^*$

Detector

* Soft decision levels may
be used also by converting
 $[0,1]$ to $[-1,1]$